RTCA Special Committee 186, Work Group 3

ADS-B 1090 MOPS, Revision A

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Proposed Enhancements to the 1090 MHz Extended Squitter MOPS

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Summary

Changes to the ADS-B MASPS were agreed by SC-186 at its plenary 10-11 April 2002. DO-260A is expected to include the specific provisions to accommodate the changes introduced in DO-242A, except for TC Reports. This working paper and its attachment include updates to the proposed DO-260A changes/additions first proposed in WG3/WP 10-09 from the 10th WG3 meeting in March 2002. The attachment includes specific proposals for 1090 MHz ADS-B MOPS revisions for intent reporting, version number reporting, message broadcast rates and event-driven message scheduling. I have attempted to align the proposed DO-260A changes with the changes to DO-242A that were agreed by SC-186 at the April Plenary.

References: Proposed ADS-B MASPS DO-242A, final draft May 2002
WG3/ WP 10-09, March 2002

Attachment A: Proposed DO-260A revisions for intent reporting, version number reporting, message broadcast rates and event-driven message scheduling

1. Background

The referenced draft DO-242A, that was produced by WG6 is an update to the current ADS-B MASPS. For a given ADS-B link, the associated MOPS will need to define the transmission rates for each of the various ADS-B messages necessary to allow the generation of the ADS-B Reports defined by the ADS-B MASPS. The ADS-B MASPS must remain independent of the ADS-B link technologies. Therefore, the MASPS requirements are expressed in terms of the effective update rate requirements for report updates as viewed by the receiving system. This is the same approach that was taken for expressing the update rate requirements in the current DO-242. The following material discusses needed changes to DO-260A that are aligned with the draft MASPS DO-242A requirements associated with intent report requirements and associated update rates. The previous MASPS requirements for TCP and TCP+1 for intent reporting have been replaced with requirements for TSR and TCR. The ADS-B link MOPS are not expected to include explicit technical provisions for supporting TCRs until the associated MASPS requirements have been validated. However, support for TSRs are expected to be included in both the UAT MOPS and the update to the 1090 ADS-B MOPS (i.e., DO-260A).

2. Discussion

The update rate requirements for TSRs that have been included in the draft DO-242A are a nominal rate of 12 seconds at 95% probability at an air-to-air range of 27 NM and at ranges beyond 27 NM the nominal update rate would linearly decrease to 18 seconds at 40 NM according to the formula 0.45 x Range. The draft DO-242A defines only desired update rates for TSR beyond 40 NM It is noted in the MASPS that future editions may require a faster update rate (e.g., 12 seconds @ 40 NM) following any significant change in the state information being conveyed in a TSR.

The message contents for the initial TC Reports are also defined by DO-242A, however neither DO-260A nor the UAT MOPS are expected to specify the requirements for supporting TCRs as this will incorporated into a later update to the MOPS. The TC Report update rates will only be defined in an Appendix to DO-242A reflecting the lack of maturity of these requirements. SC-186 has requested that, TC Reports should be addressed in an appendix to the link MOPS (i.e., DO-260A) indicating the overall longer-term requirement for Class A2 and Class A3 avionics to support TC Reports and providing a discussion of the approach that will be taken to incorporate provisions for TC Reports into a future edition of the MOPS as well as the expected performance/limitations of the link to support TC Reports.

2.1 Currently 1090 MHz ADS-B avionics (transponder-based on stand-alone ADS-B avionics) limit the overall maximum extended squitter transmission rate to 6.2 squitters per second. For transponder-based avionics, it is the responsibility of the transponder to enforce this rate limit on the extended squitter transmissions. Further, the Mode S transponder is responsible, as per DO-181C, for the broadcast of the following squitter types (while airborne) at the indicated nominal transmission rates:

- position squitter 2 per second
- velocity squitter 2 per second
- aircraft identity and type squitter 0.2 per second

All other squitters types are defined as event-driven. The contents of these event-driven squitters are defined by DO-260 while the maximum total transmission rate for the event-driven squitters is limited by the Mode S transponder MOPS (DO-181C) to 2 per second.

Currently the following types of ADS-B messages are defined by DO-260 or have been proposed for DO-260A that would use event driven squitters:

- additional aircraft identity and type messages has been considered by WG3 for DO-260A with a nominal rate of 0.2 per second (this has been discussed but no specific proposed MOPS change has been put forward to WG3)
- intent information (current nominal update is 0.588/sec for TCP and 0.588/sec for TCP+1 - see below for proposal to replace with messages to support TS Reports at a revised update rate)
- operational coordination message (DO-260: nominal rate 0.2/sec. increasing to 0.5/sec. when there is a change in the information) – NO MASPS REQUIREMENT – TO BE DELETED FROM DO-260A
- operational status message (nominal rate 0.588/sec. currently only defined to report status of TCAS and CDTI – TCAS and/or CDTI equipped aircraft would normally be broadcasting this message at the specified rate). See proposal to revise the update rate for DO-260A.
- extended squitter aircraft status (nominal rate 1/sec. and used to report emergency conditions and is only broadcast for the duration of the emergency.

Thus under ‘normal’ conditions many air carrier class aircraft with DO-260 based avionics could routinely be broadcasting event-driven messages at a rate of at least 0.588 squitters per second for an operational status message) even without any intent information, without an extra aircraft ID message, and without an emergency. Given the total set of potential message types and rates (current and future) it is clear that the total limit of 2 squitters per second for event driven messages cannot simultaneously satisfy all of the peak reporting requirements associated with all of the event-driven messages all of the time. The current DO-260 MOPS offers some recognition for the need to further define the requirements for event-driven messages in Note number 2 under para. 2.2.3.3.1.3

This MOPS contains a limited capability to adjust event-driven message rates to stay within the Event-Driven budget of 2 transmissions per second (2.2.3.3.2.10). If additional Event-Driven message types are defined, a later version of this document may define a more fully featured scheduling function that assigns rates based upon the relative priority of the Event-Driven messages.

It would appear appropriate, to address this limitation of the current MOPS in the revisions for DO-260A.

2.2 The current DO-260 broadcast rate requirements for intent (i.e., TCP and TCP+1) information are shown below in Table 1.

TABLE 1

DO-260 TCP requirements	TCP rate	TCP+1 rate	**Total Rate (squitters/sec)**
broadcast interval	1.700	1.700	
broadcast squitters/sec.	0.588	0.588	**1.176**

The draft DO-242A discusses three types of intent reports (TS Reports, TC+0 Reports and future TC+x Reports), although only TS Reports is included as requirements for the latest revision to the ADS-B MASPS. The information necessary to allow generation of a TS Reports could be broadcast within a single squitter, but TC Reports (at least certain variations of these reports) will require more data elements than could be supported in a single squitter. Consistent with the directions for the SC-186 plenary in December 2001 and again in April 2002, TS Reporting provisions will need to be included in DO-260A. WG6 is defining the minimum required elements for TC Report and these will need to be accommodated in a future update (beyond DO-260A) to the 1090 MHz ADS-B MOPS. A preliminary review of the proposed TS Report and TC Report contents, from the proposed DO-242A on the report contents and reporting rate (DO-242A appendix material for TC Reports) indicates that the long-term intent requirements for TS Reports, TC=0 and TC+1 Reports could result in a 400% to 500% increase in the intent information that needs to be conveyed per unit of time as compared to the current DO-242 requirement for TCP plus TCP+1. This represents a substantial new requirement for the ADS-B links and could have a significant impact on the link MOPS. However, in the short term SC-186 agreed to only include specific requirements in the link MOPS for TS Reports with the requirements for TC Reports to be addressed in future updates. However, DO-260A is expected to include an appendix that will discuss how and to what extent TC Reports can be accommodated by the 1090 MHz link and also what the expected link performance will be to handle TC Reporting.

One significant consideration of accommodating TC reports within a future update to the 1090 MHz. Extended Squitter MOPS will need to be to either keep the total allowed peak squitter rate at approximately the same as currently defined (i.e., 6.2 squitters per second) or to seek approval from ICAO and RTCA for allowing a higher peak total squitter rate and to revise the requirements of the Mode S transponder MOPS/SARPS related to

extended squitter transmission rates accordingly. Since for the moment we need to only consider just the near-term requirement for DO-260A to support TS Reports in the 1090 extended squitter MOPS then no increase to the total authorized peak squitter rate are proposed nor are changes to DO-181C necessary. However, the new appendix to DO-260A that will address TC Reports will need to address this issue.

2.3 The proposed changes to DO-260A in the attachment to this working paper include support for TS Reports and includes specific proposals for the update rates associated with all of the event-driven extended squitter messages. Also the proposal include placeholders for the future addition of the provisions for TC Reports. A new message type for an "Aircraft Trajectory Intent and System Status Message" is proposed (replacing the old DO-260 Aircraft Trajectory Intent message). This new message type would be used to support TS Reports and in the future TC Reports. Also the message bits not needed to convey trajectory status information would be used to convey other dynamic status information that would allow a reduced broadcast rate for "Aircraft Operational Status" messages.

2.4 The proposed message reporting rates in attachment 1 would use a nominal squitter transmission rate of once per 1.25 seconds for the new trajectory intent (i.e., associated with TS Reports) and system status message. This would directly address the proposed MASPS requirements and make for efficient use of the fixed limit of 1090ES for transmission of event-driven squitters. Table 3 below shows the required squitter reception probabilities for the case where the messages necessary to generate a TSR update has a nominal transmission rate of 0.8 message per second.

Table 2 Required Squitter Reception Probability

a-a range	Required per Squitter Reception Probability Broadcast Rage = 0.8/sec)
20 NM	0.268
40 NM	0.188

The probabilities shown in Table 2 above are for 95% probability of being able to generate a TS Report update are based on the formula: $P_{squitter} = 1 - (0.05)^{1/N}$. Where $P_{squitter}$ is the probability of individual squitter reception and N is the number of squitter transmissions within the required update interval. Thus at the maximum required range of 40 NM for TS Report updates, as per the draft DO-242A, the probability of squitter reception would need to be 18.8%. Based on data from 1090ES flight measurements in both LA and Frankfurt, this level of performance could be achieved in today's highest traffic density environments by a Class A2 receiver with enhanced reception techniques. Preliminary modeling results would suggest that such a level of performance may be possible in a postulated future LA scenario for 2020, but additional simulation work will be needed to confirm this.

2.5 Future accommodation of TC Reporting requirements may require a change to the Mode S transponder MOPS/SARPs as well as the 1090 MHz ADS-B MOPS/SARPs. Two possible alternatives available to accommodate TC+0 Reports would be:

a) to reduce the rate at which state vector information is transmitted; and/or

b) to seek approval to allow the use of a higher total peak rate for squitter transmission for those aircraft capable of reporting TCR+0 (only applicable to Class A2 and A3 avionics).

The first approach would require a change to the Mode S transponder MOPS and SARPs and although it might be possible to accommodate the TC+0 Reporting requirement without exceeding the total squitter broadcast rates currently specified for the transponder, but it is unlikely that TC+1 Reports could be accommodated with this approach. The second approach would also require approval from ICAO, RTCA and the FAA spectrum office for changes to the Mode S transponder MOPS and SARPs. The timescale for the first approach would probably be shorter than for the second but in either case the needed timeframe for the accommodation of TC+0 Reports and especially TC+1 Reports are relatively long term. Once the MASPS requirements for TC Reports are validated and we have a more mature operational concept for what aircraft are expected to be capable of broadcasting TC Reports, under what conditions and how the information may be used, then a decision will need to be made as the preferred approach to accommodate these new requirements in the 1090 MHz ADS-B system design.

3. Proposal

It is proposed that WG3 progress the development of DO-260A to:

1. define the provisions for an event-driven trajectory intent messages including a specification of the message formats and transmission rates, based attachment A to this paper, and to develop the associated test requirements associated with TS Reports as a replacement for or modification to the existing TCP related tests.

2. review and modify, as appropriate, the message contents and/or reporting rates for the event-driven messages as per attachment A to this paper in order to better utilize the 2 squitters per second allowed for the transmission of event-driven squitters

3. include requirements for a scheduling function that assigns rates based upon the relative priority of the Event-Driven messages as per attachment A to this paper including the definition of the relative priorities of all of the event-driven messages

4. develop an appendix describing the longer term need to support TCR+0 based on the provisions being introduced in DO-242A. Also include a discussion of the possible approach to supporting TCR+0 and TCR+x in the future 1090 MHz ADS-B design and the expected performance.

ATTACHMENT A

This attachment has 3 Parts:

1. DO-260A changes to support new intent reporting requirements
2. DO-260A changes to version number
3. DO-260A change for emergency priority status for align with DO-242A
4. DO-260A changes for event-driven message rates and message scheduling

PART 1

The following draft DO-260A material proposes to replace “Aircraft Trajectory Intent” Messages (Section 2.2.3.2.7.1) with “Aircraft Trajectory Intent and System Status” Messages. This new message type would provide support for TSRs and future TCRs as well as providing other status information, including NAC, SIL, TCAS status, etc. within a single message type.

2.2.3.2.7 ADS-B Intent, Operational Coordination, and Operational Status Messages

Type codes 29, 30 and 31 have been identified for Aircraft Intent, Aircraft Operational Coordination, and Aircraft Operational Status. Structure of these messages is provided in detail in the subsequent paragraphs.

2.2.3.2.7.1 "Aircraft Trajectory Intent and System Status" Messages

The "Aircraft Trajectory Intent and System Status" Message are used to provide the current state of an airborne aircraft in navigating to its intended trajectory and the status of the aircraft's navigation data source, CDTI and TCAS/ACAS systems. For this version of these MOPS the Aircraft Trajectory Intent and System Status message is defined to convey information on the aircraft's target heading and altitude (i.e. Target State information) as well as information on the status of the navigation data being used by ADS-B and the status of the aircraft CDTI and TCAS systems. The format of the Aircraft Trajectory Intent and System Status message is provided in Figure 2-8, while further definition of each of the subfields is provided in the subsequent paragraphs.

Notes:

1. *Future editions of these MOPS may include provisions for additional sub-types of aircraft trajectory intent and status messages supporting broadcast of trajectory change information. An overview of such messages is provided in Appendix tbd.*

2. *At the time of the adoption of RTCA DO-260, it was decided by RTCA SC-186 Plenary that insufficient information was known about Trajectory Change Points and their usage to broadcast a TCP Valid Flag ("ME" bit 11) set equal to one (1), indicating that the following TCP Data was "Valid," without a clear understanding of what that data represented. It was agreed that the TCP Valid Flag be set to zero (0), until the issue of TCP was resolved by changes to the ADS-B MASPS, RTCA DO-242. This would result in the TCP/TCP+1 messages not being broadcast from a RTCA DO-260 compliant airborne implementation.*

   It was further agreed by the RTCA SC-186 Plenary, which approved DO-260 that all remaining text in DO-260 regarding TCP and TCP+1 was to remain as written, without modification, except for the test procedure in subparagraph 2.4.3.2.7.1.4, which deals specifically with the TCP Valid Flag in subparagraph 2.2.3.2.7.1.4.

   In these revised MOPS (RTCA DO-260A) the provisions of RTCA DO-260 related to TCP/TCP+1 have been removed and provisions for a Aircraft Trajectory Intent and System Status message has been defined using the same message Type value (i.e, Type = 29) as previously defined by RTCA DO-260 for the Aircraft Trajectory Intent messages that conveyed TCP/TCP+1 information. It is not expected that any implementation based on RTCA DO-260 would have implemented the messages for TCP and TCP+1. However, for purposes of backward compatibility these MOPS require for a Type=29 message that "ME" bit 11 always be set to zero (0) which would result in a RTCA DO-260 conformant ADS-B receiver not attempting to make use of the remaining contents of the message. Likewise any Type = 29 message transmitted by an implementation based on DO-260 that has incorrectly set

"ME" bit 11 set to one(1) (i.e., indicating a valid TCP/TCP+1 message is being transmitted) should be discarded.

MSG BIT #	33--37	38---39	40---88
ME BIT #	1----5	6---7	8---56
FIELD NAME	TYPE=29 [5]	SUBTYPE [2]	Intent/Status Information (see 2.2.3.2.7.1.2) [49]
	MSB---LSB	MSB---LSB	MSB---LSB

Figure 2-8 "Aircraft Trajectory Intent and System Status" Message Overall Format

2.2.3.2.7.1.1 "TYPE" Subfield in Aircraft Trajectory Intent and System Status Message

The "TYPE" subfield was previously defined for the Airborne Position Message in subparagraph 2.2.3.2.3.1 and remains the same for the Aircraft Trajectory Intent and System Status Message which uses Type Code 29.

2.2.3.2.7.1.2 "SUBTYPE" Subfield in Aircraft Trajectory Intent and System Status Message

The "SUBTYPE" subfield is a 2 bit ("ME" bit 6 and 7, Message bit 38 and 39) field used to identify the format of the remainder of the Aircraft Trajectory Intent and System Status message in accordance with the encoding defined in Table 2-41.

Table 2-41: "SUBTYPE" Subfield Encoding

Encoding	Meaning
00	Target State and Status Information provided in the subsequent subfields of the message (see 2.2.3.2.7.1.3)
01	Reserved for Trajectory Change information to be conveyed in the subsequent subfields of the message
10	Reserved for Trajectory Change information to be conveyed in the subsequent subfields of the message
11	Reserved for Trajectory Change information to be conveyed in the subsequent subfields of the message

2.2.3.2.7.1.3 Target State and Status Information SUBTYPE=0 Format

TARGET STATE AND STATUS INFORMATION is conveyed by the Aircraft Trajectory Intent and System Status Message (TYPE=29) when SUBTYPE=0.

MSG BIT #	33--37	38---39	40---41	42	43	44---45
ME BIT #	1----5	6---7	8---9	10	11	12---13
FIELD NAME	TYPE=29 [5]	SUBTYPE=0 [2]	VERTICAL DATA AVAILABLE /SOURCE INDICATOR [2]	TARGET ALTITUDE TYPE [1]	BACKWARD COMPATIBILITY FLAG = 0 [1]	TARGET ALTITUDE CAPABILITY [2]
	MSB--LSB	MSB---LSB	MSB---LSB			MSB---LSB

MSG BIT #	46---47	48---57	58---59	60---68	69	70---71
ME BIT #	14---15	16----25	26---27	28---36	37	38---39
FIELD NAME	VERTICAL MODE INDICATOR [2]	TARGET ALTITUDE [10]	HORZONTAL DATA AVAILABLE/ SOURCE INDICATOR [2]	TARGET HEADING /TRACK ANGLE [9]	TARGET HEADING /TRACK INDICATOR [1]	HORZ. MODE INDICATOR [2]
	MSB---LSB	MSB---LSB	MSB--LSB	MSB--LSB		MSB--LSB

MSG BIT #	72---75	76	77---78	79---83	84---85	86---88
ME BIT #	40-43	44	45---46	47---51	52---53	54---56
FIELD NAME	NAC_P [4]	NIC_{bar_o} [1]	SIL [2]	Reserved [5]	CAPABILTY /MODE CODES [2]	EMERGENCY /PRIORITY [3]
	MSB--LSB		MSB--LSB	MSB--LSB	MSB--LSB	MSB--LSB

Figure 2-9 “Target State and Status Information” SUBTYPE=0 Format

2.2.3.2.7.1.3.1 "VERTICAL DATA AVAILABLE/SOURCE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "VERTICAL DATA AVAILABLE/SOURCE INDICATOR" subfield is a 2 bit ("ME" bits 8 and 9, Message bits 40 and 41) field used to identify if aircraft vertical state information is available and present as well as the data source for the vertical data when present in the subsequent subfields ("ME" bit 10 through 25, Message bit 42 through 57) of the Aircraft Trajectory Intent and System Status message. The "VERTICAL DATA AVAILABLE/SOURCE INDICATOR" subfield is encoded in accordance with Table 2-41. If the "VERTICAL DATA AVAILABLE/SOURCE INDICATOR" subfield is encoded with a value of 00, the target altitude related data in the subsequent subfields is be ignored.

Table 2-41: "VERTICAL DATA AVAILABLE/SOURCE INDICATOR" Subfield Encoding

Encoding	Meaning
00	No valid vertical Target State data is available
01	Autopilot control panel selected value, such as Mode Control Panel (MCP) or Flight Control Unit (FCU)
10	Holding Altitude
11	FMS/RNAV System

2.2.3.2.7.1.3.2 "TARGET ALTITUDE TYPE" Subfield in Aircraft Trajectory Intent and System Status Message

The "TARGET ALTITUDE TYPE" subfield is a 1 bit ("ME" bit 10, Message bit 42) field used to identify the altitude reported in the "TARGET ALTITUDE" subfield is referenced to mean sea level (MSL) or to a flight level (FL) in accordance with the encoding defined in Table 2-42.

Table 2-42: "TRAJECTORY TYPE" Subfield Encoding

Encoding	Meaning
0	Target Altitude referenced to Pressure Altitude (Flight Level)
1	Target Altitude referenced to Baro-Corrected Altitude (Mean Sea Level)

2.2.3.2.7.1.3.3 "BACKWARD COMPATIBILITY FLAG" Subfield in Aircraft Trajectory Intent and System Status Message

The "BACKWARD COMPATIBLITY FLAG" subfield is a 1 bit ("ME" bit 11, Message bit 43) field used to provide backward compatible for version 0 (zero) 1090 MHz. ADS-B systems based on the initial version of these MOPS (i.e., in RTCA DO-260). RTCA DO-260 designated message TYPE = 29 for TCP and TCP+1 messages. RTCA DO-260 required the "TCP/TCP+1 DATA VALID" subfield ("ME" bit 11) to be encoded with a value of zero, indicating the TCP/TCP+1 information in the message is not valid. For the current version of these MOPS where message TYPE = 29 is no longer being used for TCP/TCP+1 messages, backward capability is provided by always setting "ME" bit 11 to a

value of zero (0) in order to ensure that any receiving system based on the first version of these MOPS (i.e., based on RTCA DO-260) will ignore the contents of this message. Any TYPE=29 message received with the "Backward Compatibility Flag" set to one (1) indicates an invalid message that should be discarded. The "Backward Compatibility Flag" subfield is encoded in accordance Table 2-43.

Table 2-43: "BACKWARD COMPATIBILITY FLAG" Subfield Encoding

Encoding	Meaning
0	Required Value
1	Invalid Message (discard entire Aircraft Trajectory Intent and System Status Message)

2.2.3.2.7.1.3.4 "TARGET ALTITUDE CAPABILITY" Subfield in Aircraft Trajectory Intent and System Status Message

The "TARGET ALTITUDE CAPABILITY" subfield is a 2 bit ("ME" bits 12 and 13, Message bits 44 and 45) field used to describe the aircraft's capabilities for providing the data reported in the "TARGET ALTITUDE" subfield. The "TARGET ALTITUDE CAPABILITY" subfield is encoded in accordance with Table 2-44.

Table 2-44: "TARGET ALTITUDE CAPABILITY" Subfield Encoding

Encoding	Meaning
00	Capability for reporting holding altitude only
01	Capability for reporting either holding altitude or autopilot control panel selected altitude
10	Capability for reporting either holding altitude, autopilot control panel selected altitude, or any FMS/RNAV level-off altitude
11	Reserved

2.2.3.2.7.1.3.5 "VERTICAL MODE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "VERTICAL MODE INDICATOR" subfield is a 2 bit ("ME" bits 14 and 15, Message bits 46 and 47) field used to indicate whether the target altitude is in the process of being acquired (i.e., aircraft is climbing or descending toward the target altitude) or whether the target altitude has been acquired/being held. The "VERTICAL MODE INDICATOR" subfield is encoded according to Table 2-45.

Table 2-45: "VERTICAL MODE INDICATOR" Subfield Encoding

Encoding	Meaning
00	Unknown Mode or Information Unavailable
01	"Acquiring" Mode
10	"Capturing" or "Maintaining" Mode
11	Reserved

2.2.3.2.7.1.3.6 "TARGET ALTITUDE" Subfield in Aircraft Trajectory Intent and System Status Message

The "TARGET ALTITUDE" subfield is a 10 bit ("ME" bits 16 through 25, Message bits 48 through 57) field used to provide aircraft's next intended level-off altitude if in a climb or descent, or the aircraft current intended altitude if it is intending to hold its current altitude. It is intended that the reported "TARGET ALTITUDE" be the operational altitude recognized by the aircraft's guidance system. The reported "TARGET ALTITUDE" shall be consistent with the reported "TARGET ALTITUDE CAPABILTY" as defined in 2.2.3.2.7.1.3.4. The "TARGET ALTITUDE" subfield is encoded in accordance with Table 2-46.

Table 2-46: "TARGET ALTITUDE" Subfield Encoding

Coding (binary)	**Coding** (decimal)	**Meaning**
00 0000 0000	0	Target Altitude = -1000 feet
00 0000 0001	1	Target Altitude = -900 feet
00 0000 0010	2	Target Altitude = -800 feet
***	***	***
00 0000 1011	11	Target Altitude = zero (0) feet
00 0000 1100	12	Target Altitude = 100 feet
***	***	***
11 1111 1110	1022	Target Altitude = 101,200 feet
11 1111 1111	1023	Target Altitude = 101,300 feet

2.2.3.2.7.1.3.7 "HORIZONTAL DATA AVAILABLE/SOURCE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "HORIZONTAL DATA AVAILABLE/SOURCE INDICATOR" subfield is a 2 bit ("ME" bits 26 and 27, Message bits 58 and 59) field used to identify if aircraft horizontal state information is available and present as well as the data source for the horizontal target data when present in the subsequent subfields ("ME" bit 28 through 39, Message bit 60 through 71) of the Aircraft Trajectory Intent and System Status message. The "HORIZONTAL DATA AVAILABLE/SOURCE INDICATOR" subfield is encoded in accordance with Table 2-47. If the "HORIZONTAL DATA AVAILABLE/SOURCE INDICATOR" subfield is encoded with a value of 00, the target heading related data in the subsequent subfields is be ignored.

Table 2-47: "HORIZONTAL DATA AVAILABLE /SOURCE INDICATOR" Subfield Encoding

Encoding	**Meaning**
00	No valid horizontal Target State data is available
01	Autopilot control panel selected value, such as Mode Control Panel (MCP) or Flight Control Unit (FCU)
10	Maintaining current heading or track angle (e.g., autopilot mode select)
11	FMS/RNAV System (indicates track angle specified by leg type)

2.2.3.2.7.1.3.8 "TARGET HEADING/TRACK ANGLE" Subfield in Aircraft Trajectory Intent and System Status Message

The "TARGET HEADING/TRACK ANGLE" subfield is a 9 bit ("ME" bits 28 through 36, Message bits 60 through 68) field used to provide aircraft's intended (i.e., target or selected) heading or track. The "TARGET ALTITUDE" subfield is encoded in accordance with Table 2-48.

Table 2-48: "TARGET HEADING/TRACK ANGLE" Subfield Encoding

Coding (binary)	**Coding** (decimal)	**Meaning**
0 0000 0000	0	Target Heading/Track = Zero degrees
0 0000 0001	1	Target Heading/Track = 1 degrees
0 0000 0010	2	Target Heading/Track = 2 degrees
***	***	***
1 0110 0111	359	Target Heading/Track = 359 degrees
1 0110 1000 through 1 1111 1111	360 through 511	Invalid

2.2.3.2.7.1.3.9 "TARGET HEADING/TRACK INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "TARGET HEADING/TRACK INDICATOR" subfield is a 1 bit ("ME" bit 37, Message bit 69) field used to indicate whether an air reference heading angle or a ground referenced track angle is being reported in the "TARGET HEADING/TRACK ANGLE" subfield. The "TARGET HEADING/TRACK INDICATOR" subfield is encoded according to Table 2-49.

Table 2-49: "TARGET HEADING/TRACK INDICATOR" Subfield Encoding

Encoding	**Meaning**
0	Air-referenced Target Heading Angle being reported
1	Ground-referenced Target Track Angle being reported

2.2.3.2.7.1.3.10 "HORIZONTAL MODE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "HORIZONTAL MODE INDICATOR" subfield is a 2 bit ("ME" bits 38 and 39, Message bit 70 and 71) field used to indicate whether the target heading/track is being acquired (i.e., lateral transition toward the target direction is in progress) or whether the target heading/track has be acquired and the currently be maintained. The "HORIZONTAL MODE INDICATOR" subfield is encoded according to Table 2-50.

Table 2-50: "HORIZONTAL MODE INDICATOR" Subfield Encoding

Encoding	**Meaning**
00	Unknown Mode or Information Unavailable
01	"Acquiring" Mode
10	"Capturing" or "Maintaining" Mode
11	Reserved

2.2.3.2.7.1.3.11 "NAC_P" Subfield in Aircraft Trajectory Intent and System Status Message

The "NAC_P" subfield is a 4 bit ("ME" bits 40 through 43, Message bits 72 through 75) field used to indicate accuracy category of the navigation information used as the basis for the aircraft reported position. The "NAC_P " subfield is encoded according to Table 2-51.

Table 2-51: "NAC_P" Subfield Encoding

Encoding	Meaning = 95% Horisontal and Vertical Accuracy Bounds (EPU and VEPU)
0000	EPU ≥ 18.52 km (10 NM) - Unknown accuracy
0001	EPU < 18.52 km (10 NM) - RNP-10 accuracy
0010	EPU < 7.408 km (4 NM) - RNP-4 accuracy
0011	EPU < 3.704 km (2 NM) - RNP-2 accuracy
0100	EPU < 1852 m (1NM) - RNP-1 accuracy
0101	EPU < 926 m (0.5 NM) - RNP-0.5 accuracy
0110	EPU < 555.6 m (0.3 NM) - RNP-0.3 accuracy
0111	EPU < 185.2 m (0.1 NM) - RNP-0.1 accuracy
1000	EPU < 92.6 m (0.05 NM) - e.g., GPS (with SA)
1001	EPU < 30 m and VEPU < 45 m - e.g., GPS (SA off)
1010	EPU < 10 m and VEPU < 15 m - e.g., WAAS
1011	EPU < 3 m and VEPU < 4 m - e.g., LAAS
1100-- 1111	Not Assigned

2.2.3.2.7.1.3.12 "NIC_{baro}" Subfield in Aircraft Trajectory Intent and System Status Message

The "NIC_{baro}" subfield is a 1 bit ("ME" bit 44, Message bit 76) field used to indicate whether or not the barometric pressure altitude being reported in the Airborne Position Message (2.2.3.2.3) has been cross-checked against another source of pressure altitude. The "NIC_{baro} " subfield is encoded according to Table 2-52.

Table 2-52: "NIC_{baro}" Subfield Encoding

Encoding	Meaning
0	The barometric altitude that is being reported in the Airborne Position Message has not been cross-checked against another source of pressure altitude
1	The barometric altitude that is being reported in the Airborne Position Message has been cross-checked against another source of pressure altitude and verified as being consistent

Note: The NIC value itself is conveyed within the ADS-B Position message.

2.2.3.2.7.1.3.13 "SIL" Subfield in Aircraft Trajectory Intent and System Status Message

The "SIL" subfield is a 2 bit ("ME" bits 45 and 46, Message bits 77 and 78) field used to define the probability of the integrity containment radius used in the NIC

subfield being exceeded, without alerting, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used by the navigation source. The "SIL " subfield is encoded according to Table 2-53.

Table 2-53: "SIL" Subfield Encoding

Encoding	Meaning Probability of Exceeding the Integrity Containment Radius Reported in the NIC Subfield Without Detection
00	Unknown
01	1×10^{-3} per flight hour or per operation
10	1×10^{-5} per flight hour or per operation
11	1×10^{-7} per flight hour or per operation

2.2.3.2.7.1.3.14 "CAPABILITY/MODE CODES" Subfield in Aircraft Trajectory Intent and System Status Message

The "CAPABILITY/MODE CODES" subfield is a 2 bit ("ME" bits 52 and 53, Message bits 84 and 85) field used to indicate the current operational status of TCAS/ACAS systems/functions. The "CAPABILITY/MODE CODES" subfield is encoded according to Table 2-54 as two individual 1-bit length data elements that each indicate the status of a specific system or function on the transmitting aircraft

Table 2-54: "CAPABILITY/MODE CODES" Subfield Encoding

Encoding	Meaning
ME bit 52 = 0	TCAS/ACAS operational or unknown
ME bit 52 = 1	TCAS/ACAS not operational
ME bit 53 = 0	No TCAS/ACAS Resolution Advisory active
ME bit 53 = 1	TCAS/ACAS Resolution Advisory active

2.2.3.2.7.1.3.15 "EMERGENCY/PRIORITY STATUS" Subfield in Aircraft Trajectory Intent and System Status Message

The "EMERGENCY/PRIORITY STATUS" subfield is a 3 bit ("ME" bits 54 through 56, Message bits 86 through 88) field used to provide additional information regarding aircraft status. The "EMERGENCY/PRIORITY STATUS" subfield is encoded according to Table 2-55.

Table 2-55: "EMERGENCY/PRIORITY STATUS" Subfield Encoding

Encoding	Meaning
000	No emergency
001	General emergency
010	Lifegard/medical emergency
011	Minimum fuel
100	No communications
101	Unlawful interference
110	Downed Aircraft
111	Reserved

2.2.3.2.7.1.4 Target Change Information SUBTYPE=1 Format

This section is reserved for future editions of these MOPS to define Target Change Information to be conveyed by the Aircraft Trajectory Intent and System Status Message (TYPE=29) when SUBTYPE=1.

PART 2

The following draft DO-260A material proposes provisions for the version number subfield in the Aircraft Operational Status Message (tentative para. 2.2.3.2.7.3.5). The intent of the proposed changes from the previous reviewed draft text on version numbers is to provide more explicit statements on the backward and forward interoperability of equipment built to different versions of the MOPS.

<<< NOTE: The proposed change is the same as proposed in WG3/WP 10-09 >>>

x.x.x Version Number Subfield in Aircraft Operational Status Message

The "Version Number" subfield is a 3-bit ("ME" bits 41 through 43, Message bits 73 through 75) field used to indicate the Version Number of the formats and protocols in use on the aircraft installation. Encoding of the Version Number subfield shall be as shown in Table 2-xx. Airborne ADS-B systems conformance to the initial version of the 1090 MHz ADS-B MOPS (DO-260) do not broadcast an explicit version number. Therefore, ADS-B Receiving Subsystems conformant with this version of the 1090 MHz MOPS will initially assume a Version Number of ZERO (binary 000), until received Version Number data indicates otherwise.

Future versions of these RTCA MOPS are expected to maintain backward compatibility with DO-260A. Messages originating from 1090 MHz ADS-B aircraft reporting a MOPS VERSION NUMBER value that is indicated in Table 2-xx as "reserved" are to be considered valid. However, all message types and all subfields within messages that are currently "unassigned" or are indicated as being "reserved" by these MOPS shall be ignored and not used for ADS-B report generation.

Table 2-xx: "VERSION NUMBER" Subfield Encoding

Encoding	Meaning
000	Reserved for implementation conformance to DO-260
001	Version Number to be reported for implementations conformant to RTCA DO-260A
010 though 111	Reserved (for implementations conformant to future version of the 1090 MHz ADS-B MOPS).

PART 3

Update to Appendix A, Figure A-9

Proposed Change: Add Emergency/Priority Status Coding for value 6 = Downed Aircraft

Reason: To align with change in DO-242A

<<< NOTE: The proposal has not changed from WG3/WP 10-09 >>>

PART 4

The following draft DO-260A material proposes requirements for event-driven message broadcast rates and provisions for a message scheduling function for event-driven messages. These proposed changes are intended to make the most efficient use of the available 1090ES link capacity for supporting event-driven messages.

2.2.3.3.1.4 ADS-B Event-Driven Message Broadcast Rates

2.2.3.3.1.4.1 ADS-B Aircraft Trajectory Intent and System Status Message Broadcast Rates

a. The Aircraft Trajectory Intent and System Status Message(s) (message TYPE=29, Section 2.2.3.2.7.1) shall be initiated only when the aircraft is airborne and when vertical and/or horizontal trajectory intent information is available and valid as a minimum.

a. The Aircraft Trajectory Intent and System Status Message with a SUBTYPE subfield value of zero (0) shall, for the nominal case, be broadcast at random intervals that are uniformly distributed over the range of 1.2 to 1.3 seconds relative to the previous Aircraft Trajectory Intent Message and System for as long as data is available to satisfy the requirements of subparagraph "a." above.

b. The broadcast rates for Aircraft Trajectory Intent and System Status Messages with a SUBTYPE subfield value of other than zero (0) are not defined by this version of these MOPS.

Note 1: Future versions of these MOPS may require unique broadcast update intervals for each Aircraft Trajectory Intent and System Status Message SUBTYPE (i.e., unique for each value of the SUBTYPE subfield).

Note 2: Future versions of these MOPS may require that the broadcast rate for Aircraft Trajectory Intent and System Status Messages be temporarily increased (e.g., for 24 seconds) following any change in intent or status information.

2.2.3.3.1.4.2 ADS-B Aircraft Operational Status Message Broadcast Rates

The rate at which the Aircraft Operational Status Messages (message TYPE=31 and SUBTYPE=0, Section 2.2.3.2.7.3) are to be broadcast varies depending on the following conditions:

Condition 1: Aircraft Trajectory Intent and System Status message (2.2.3.2.7.1) is not being broadcast versus being broadcast.

Condition 2: There has been a change within the past 24 seconds in the value of one or more of the following parameters included in the Operational Status Message

a. TCAS/ACAS Operational

b. ACAS/TCAS resolution advisory active

c. NAC_p

d. SIL

a. For the two cases where:

i. the Aircraft Trajectory Intent and System Status message (2.2.3.2.7.1) is not being broadcast and Condition 2 above is not applicable (nominal condition); or

ii. the Aircraft Trajectory Intent and System Status message is being broadcast regardless of the applicability of Condition 2 above;

The Aircraft Operational Status message shall be broadcast at random intervals uniformly distributed over the range of 2.4 to 2.6 seconds.

b. For the case where the Aircraft Trajectory Intent and System Status message (2.2.3.2.7.1) is not being broadcast and Condition 2 above is applicable, the Aircraft Operational Status message broadcast rate shall be increased for a period of 24 seconds (+/- 1 second) such that the broadcasts occur at random intervals that are uniformly distributed over the range of 0.75 to 0.85 seconds.

2.2.3.3.1.4.3 "Extended Squitter Aircraft Status" ADS-B Event - Driven Message Broadcast Rate

The rate at which the "Extended Squitter Aircraft Status" (Type 28), "Emergency/Priority Status" ADS-B Event - Driven Message (Subtype =1) shall be broadcast varies depending on whether the "Aircraft Trajectory Intent and System Status Message" (2.2.3.2.7.1) is not being broadcast versus being broadcast.

a. In the case where the "Aircraft Trajectory Intent and System Status Message" with Subtype = zero (0) is not being broadcast the "Emergency/Priority Status" shall be broadcast at random intervals that are uniformly distributed over the range of 0.75 to 0.85 seconds relative to the previous Emergency/Priority Status Message for the duration of the emergency condition established in accordance with Appendix A, Figure A-9, Note 2.

b. In the case where the "Aircraft Trajectory Intent and System Status Message" with Subtype = zero (0) is being broadcast the "Emergency/Priority Status" shall be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds relative to the previous Emergency/Priority Status Message for the duration of the emergency condition established in accordance with Appendix A, Figure A-9, Note 2.

2.2.3.3.1.4.4 "TYPE 23 (TEST)" ADS-B Event - Driven Message Broadcast Rate

The "TEST" ADS-B Event - Driven Messages shall be broadcast NOT MORE THAN ONCE each time the Event Driven Test Information is updated to the transponder

2.2.3.3.1.4.5 "TYPE 24 - 27" ADS-B Event - Driven Message Broadcast Rate

In general, TYPE 24 - 27 ADS-B Event - Driven Messages shall be broadcast ONCE each time the Event-Driven TYPE 24 - 27 information is updated to the transponder.

2.2.3.3.1.4.6 ADS-B Message Transmission Scheduling

An ADS-B message scheduling function shall be used to determine the sequence of ADS-B messages to be broadcast and to control the overall transmission rate of event-driven messages.

2.2.3.3.1.4.6.1 Event-Driven Message Scheduling Function

The Event-driven Message Scheduling Function shall ensure that the total Event-Driven message rate does not exceed 2 transmitted messages per second. This is consistent with the required overall maximum allowed transmission rate specified in section 2.2.3.3.1.3.

The Event-Driven Message Scheduling Function shall apply the following rules as a means of prioritizing the Event-Driven message transmissions and limited the transmission rates:

a. The Event-Driven message scheduling function shall reorder, as necessary, pending Event-Driven messages according to the following message priorities, listed below in descending order from highest to lowest priority:

   i. When an Extended Squitter Status Message (2.2.3.2.7.9) is active for the broadcast of an Emergency/Priority Condition (message TYPE=28 and SUBTYPE=1), it shall continue to be transmitted at the rate specified in Section 2.2.3.3.1.4.3 for the duration of the emergency/priority condition.

   ii. Reserved for future use.

      Note: This priority level may be used in a future version of these MOPS for the case when an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory state information (message TYPE=29 and SUBTYPE=0) and there has been a change in one or more of the message parameters that results in a higher update rate reporting requirement.

   iii. Reserved for future use.

      Note: This priority may be used in a future version of these MOPS for the case when an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory change information (message TYPE=29 and SUBTYPE > 0) and there has been a change in one or more of the message parameters that results in a higher update rate reporting requirement.

   iv. When an Aircraft Operational Status Message (2.2.3.2.7.3) is active (message TYPE=31 and SUBTYPE=0) and there has been a change in one or more of the message parameters within the past 24 seconds that results in a higher update rate reporting requirement, the Aircraft Operational Status Message shall be transmitted at the nominal rate specified in section 2.2.3.3.1.4.2.

   v. When an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory state information (message TYPE=29 and SUBTYPE=0) the Aircraft Trajectory Intent and System Status message shall be transmitted at the nominal rate specified in section 2.2.3.3.1.4.1.

   vi. Reserved for future use.

      Note: This priority level may be used in a future version of these MOPS for the case when an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of

trajectory change information (message TYPE=29 and SUBTYPE > 0) at a nominal rate.

vii. When an Aircraft Operational Status Message (2.2.3.2.7.3) is active (message TYPE=31 and SUBTYPE=0) and is being broadcast at a nominal rate, the Aircraft Operational Status Message shall be transmitted at the rate specified in section 2.2.3.3.1.4.2.

viii. This priority level applies as a default to any event-driven message TYPE and SUBTYPE combination not specifically identified at a higher priority level above. Event-Driven messages of this default priority level shall be delivered to the transponder on a first-in-first-out basis at equal priority.

b. The Event-Driven message scheduling function shall limit the number of Event-Driven messages provided to the transponder to two (2) messages per second.

Note: *It is possible that future versions of these MOPS, and requiring a complementary change to the Mode S transponder MOPS, will allow for Event-Driver messages to be transmitted at a rate of greater than the current limit of two (2) messages per second. Therefore, a means should be provided to allow for a future adjustment to the value used for the message rate limit in the Event-Driven Message scheduling function.*

c. If (b) results in a queue of messages awaiting delivery to the transponder, the higher priority pending messages, according the (a) above shall be delivered to the transponder for transmission before lower priority messages.

d. If (b) results in a queue of messages awaiting delivery to the transponder, new Event-Driven messages shall directly replace older messages of the same exact Type and Subtype (where a Subtype is defined) that are already in the pending message queue. The updated message shall maintain the same position in the message queue as the pending message that is being replaced.

e. If (b) above results in a queue of messages awaiting delivery to the transponder, then pending message(s), shall be deleted from the message transmission queue if not delivered to the transponder for transmission, or not replaced with a newer message of the same message Type and Subtype, within the Message Lifetime value specified in the Table 2-64 below:

Table 2-64: Event-Drive Message Lifetime

Message TYPE	Message SUBTYPE	Message Lifetime (seconds)
23		reserved (see note)
24		reserved (see note)
25		reserved (see note)
26		reserved (see note)
27		reserved (see note)
28	=1 0, >1	5.0 seconds (+/- 0.2 sec.) reserved (see note)
29		reserved (see note)
30	=0 >0	2.5 seconds (+/- 0.2 sec.) reserved (see note)
31	=0 >0	5.0 seconds (+/- 0.2 sec.) reserved (see note)

Note: A default message lifetime of 20 seconds shall be used for queue management unless otherwise specified

2.2.3.3.2 Transmission Rates for Stand - Alone Transmitters

a. Transmitters for Class A0 and Class B equipment may be implemented independent of a Mode S transponder. Such transmitters shall meet the transmission rate requirements of section 2.2.3.3.1.3 and the message update rate requirements specified in the following subparagraphs.

b. Extended squitter messages shall be transmitted at random intervals that are uniformly distributed over the specified time interval using a time quantization no greater than 15 milliseconds.

Note: *The possible transmission time epochs should not be correlated with UTC to preclude inadvertent synchronization of transmissions from different aircraft.*

2.2.3.3.2.1 Power-On Initialization and Start Up

2.2.3.3.2.1.1 Power-On Initialization

a. At power-up initialization, the ADS-B transmission device shall start operations in a mode in which it transmits **NO** messages.

b. Given that appropriate message data is provided to the ADS-B transmission device, the transmission device shall be capable of transmitting ADS-B messages no later than 2.0 seconds after Power-On.

c. After a power-up initialization exceeding the momentary power interruption capability of the equipment, the total set of BITE tests that check all

necessary functions of the ADS-B device shall be completed within 20 seconds. As a minimum, the BITE tests shall include RAM, ROM, I/O, Timing, CPU instruction integrity, and any associated RF hardware tests necessary to ensure proper functioning of the ADS-B device.

2.2.3.3.2.1.2 Start Up

a. The ADS-B transmission device shall initiate broadcast transmissions of the Airborne Position, Surface Position, Aircraft Identification and Type, Velocity, and/or Event-Driven messages only once it has received appropriate data to structure at least one variable data field of the respective message. As such, each message shall be initiated individually and independently of the other messages.

   The single exception is presented by Altitude data in the Airborne Position message which shall be processed as follows:

   The ADS-B transmission device shall not initiate broadcast of the Airborne Position message until horizontal position data has been received. That is, that altitude data alone shall not be sufficient to initiate broadcast of the Airborne Position Message.

b. Once ADS-B message transmission has been initiated the transmission rate of each type of ADS-B message shall be as provided in the following paragraphs.

2.2.3.3.2.2 ADS-B Airborne Position Message Broadcast Rate

Once started, ADS-B Airborne Position Messages shall be broadcast by the transmission device when in the Airborne state at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Airborne Position Message, with the exceptions as specified in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.3 ADS-B Surface Position Message Broadcast Rate

a. Once started, ADS-B Surface Position Messages shall be broadcast by the transmission device when in the On-Ground state using either the “High” or “Low” rate which has been selected as follows:

   (1). Switching from “High” rate to “Low” Rate:

      (a). The broadcast rate shall be changed from “High” to “Low” when the navigation source position data has not changed more than 10 meters in a 30 second sampling interval.

         Note: *It is acceptable to compute the 10 meter distance using either rectangular or polar coordinates.*

      (b). Upon selecting the “Low” rate, the transmission device shall save the Position data at the time that the “Low” rate was selected.

   (2). Switching from “Low” rate to “High” Rate:

      The broadcast rate shall be changed from “Low” to “High” when the position of the transmission device has changed by 10 meters or more since the “Low” rate was selected.

Note: *It is acceptable to compute the 10 meter distance using either rectangular or polar coordinates.*

b. If the "High" rate is selected, then the Surface Position Message shall be transmitted at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Surface Position Message.

c. If the "Low" rate is selected, then the Surface Position Messages shall be transmitted at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds relative to the previous Surface Position Message.

Note: *Pending further study and analysis of surface broadcast rates and their triggering mechanisms by regulatory authorities, it is widely assumed that the "Low" rate will be raised to a nominal rate approaching once per second.*

d. In the event that the transmission device cannot determine the required transmission rate, then the "High" rate shall be used as the default transmission rate.

e. Exceptions to these transmission rate requirements are defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.4 ADS-B Aircraft Identification and Type Message Broadcast Rate

a. Once started, ADS-B Aircraft Identification and Type Messages shall be broadcast by the transmission device at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds relative to the previous Identification and Type Message, when the ADS-B transmitting device is reporting the Airborne Position Message, or when reporting the Surface Position Message at the high rate.

b. When the Surface Position Message is being reported at the low surface rate, then the Aircraft Identification and Type Message shall be broadcast at random intervals that are uniformly distributed over the range of 9.8 to 10.2 seconds relative to the previous Identification and Type Message.

c. When neither the Airborne Position Message nor the Surface Position Message is being transmitted, then the Aircraft Identification and Type Message shall be broadcast at the rate specified in subparagraph a.

d. Exceptions to these transmission rate requirements are defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.5 ADS-B Velocity Information Message Broadcast Rate

a. Once started, ADS-B Velocity Information Messages shall be broadcast by the transmission device at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Velocity Information Message.

b. Exceptions to these transmission rate requirements are defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.6 ADS-B Trajectory Intent and Status Message Broadcast Rates

2.2.3.3.2.6.1 ADS-B Aircraft Trajectory Intent and System Status Message Broadcast Rates

a. The requirements of Section 2.2.3.3.1.4.1 are applicable.

c. The Aircraft Trajectory Intent and System Message (TYPE=29, SUBTYPE=0, Section 2.2.3.2.7.1) shall be broadcast at random intervals that are uniformly distributed over the range of 1.2 to 1.3 seconds relative to the previous Aircraft Trajectory Intent and System Status Message for as long as data is available to satisfy the requirements of subparagraph "a." above.

b. Exceptions to these transmission rate requirements are defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.6.2 ADS-B Aircraft Operational Status Message Broadcast Rates

a. The rate at which the Aircraft Operational Status Messages (message TYPE=31 and SUBTYPE=0, Section 2.2.3.2.7.3) are to be broadcast varies as defined in Section 2.2.3.3.1.4.2.

b. Exceptions to these transmission rate requirements are defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.6.3 "Extended Squitter Aircraft Status" ADS-B Event - Driven Message Broadcast Rate

a. The rate at which the "Extended Squitter Aircraft Status" (Type 28), "Emergency/Priority Status" ADS-B Event-Driven Message (Subtype =1) shall be broadcast varies as defined in Section 2.2.3.3.1.4.3.

b. The exceptional conditions specified in 2.2.3.3.2.9 shall be observed.

2.2.3.3.2.7 "TYPE 23 (TEST)" ADS-B Event - Driven Message Broadcast Rate

The "TEST" ADS-B Event - Driven Messages shall be broadcast ***NOT MORE Than*** ONCE each time the Event Driven Test Information is updated to the ADS-B transmission device. The delay conditions specified in 2.2.3.3.2.9 shall be observed.

2.2.3.3.2.8 "TYPE 24 - 27" ADS-B Event - Driven Message Broadcast Rate

In general, TYPE 24 - 27 ADS-B Event - Driven Messages shall be broadcast ONCE each time the Event Driven TYPE 24 - 27 Information is updated to the ADS-B transmission device. The delay conditions specified in 2.2.3.3.2.9 shall be observed.

2.2.3.3.2.9 ADS-B Message Transmission Scheduling

An ADS-B message scheduling function shall be used to determine the sequence of ADS-B messages to be broadcast and to control the overall transmission rate of event-driven messages.

As an exception to the general requirement for the transmission of ADS-B messages, the scheduled message transmission shall be delayed if a Mutual Suppression interface is active.

2.2.3.3.2.9.1 Position, Velocity and Identification Message Scheduling

The priority for transmission (from highest to lowest) for the message types that are not event-driven shall be:

a. Position Message (either Airborne Position Message, as defined in Section 2.2.3.2.3, or Surface Position Message, as defined in 2.2.3.2.4)

b. Airborne Velocity Message (2.2.3.2.6.3)

c. Aircraft Identification and Type Message (2.2.3.2.5)

2.2.3.3.2.9.2 Event-Driven Message Scheduling

An Event-Driven Message Scheduling function shall:

a. Ensure that the total Event-Driven message rate does not exceed 2 transmitted messages per second. This is consistent with the required overall maximum allowed transmission rate specified in section 2.2.3.3.2.10.

   Note: It is possible that future versions of these MOPS may allow for Event-Driver messages to be transmitted at a rate of greater than the current limit of two (2) messages per second. Therefore a means should be provided to allow for a future adjustment to the value used for the message rate limit in the Event-Driven Message scheduling function.

b. Apply the rules specified in Section 2.2.3.3.1.4.6.1 as the means of prioritizing the Event-Driven message transmissions and controlling the transmission rates.

2.2.3.3.2.10 Maximum ADS-B Message Transmission Rates

The maximum ADS-B message transmission rate of non-transponder ADS-B transmitter implementations shall not exceed 6.2 transmitted messages per second.

Note: It is possible that future versions of these MOPS may allow for ADS-B messages to be transmitted at a rate of greater than the current limit of 6.2 messages per second. Therefore a means should be provided to allow for a future adjustment to the value used for the message rate limit in the message scheduling function.